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Polymer Nanocomposites for Advanced Automobile Applications

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Abstract

The automotive industry is one major sector that consume material such as plastic at the advanced technological level. Hence, automotive plastics are now gaining attention due to the desire for light weight and low CO2 emission from vehicles. It is therefore anticipated that polymer nanocomposites will significantly enhance the performance of current technologies for car industries due to their excellent mechanical, chemical, thermal, electrical and barrier properties and their influence on fire retardancy. Hence, with the use of polymer nanocomposites, the encouraging outcomes in different sectors of automotive industry has resulted to new horizons in terms of advanced polymer nanocomposites for automobile applications. This chapter reviews advance polymer composites for automobile applications. Methods of fabricating polymer nanocomposites and several applications of polymer nanocomposites in automotive industries are discussed.

Chapter Preview

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Introduction

A nanocomposite is a matrix to which nano-sized particles have been added in order to enhance a specific property of a material. Nanocomposites are usually found in nature, as a multiphase solid material in which one of the phases has one, two or three dimensions of less than 100 nm, or structures having nano-scale repeat distances between the different phases that make up the material (Majumder, Majumder, & Karan, 2013). The properties of nanocomposites depend on a range of variables, mainly the matrix material, which can exhibit nanoscale dimensions, size, shape, loading, degree of dispersion and orientation of the nanoscale second phase together with interactions between the matrix and the second phase (Ashby, Ferreira, & Schodek, 2009). Hence, the properties of composites are a function of the properties of the constituent phases, their relative amounts, and the geometry of the dispersed phase. Nanocomposite matrix is classified into metal matrix, ceramic matrix and polymer matrix. Polymer-based nanocomposites are high performance materials that exhibit unusual property combinations and a distinctive design possibility (Camargo, Satyanarayana, & Wypych, 2009). Their potential is so promising that they are useful in several applications ranging from automobile, to aerospace and biomedical. Hence, various nanocomposite materials have been developed for use in aerospace industries in the past five years. Nonetheless, the raw materials are expensive and the manufacturing process needs long production cycle times. These considerations have made nanocomposites exorbitant in automotive industries, where the components need to be mass-produced at much lower cost (see Figure 1) (Naskar, Keum, & Boeman, 2016).

Figure 1.
Relative performance and cost profiles in nanocomposite manufacturing

(Naskar, Keum, & Boeman, 2016)
Suspended nanoparticles in polymer melt or solution usually yield nanocomposites comprising of random mixtures of structural building blocks of particles and polymers with slight improvement in mechanical toughness. The solvent-based gel of the building blocks is usually cast into a film or tape, with the solvent being taken out via evaporation or coagulation. Melt-based nanocomposites, when extruded in sheet form, achieve positioning and ordered structure via shear-induced alignment of components in the material (Naskar, Keum, & Boeman, 2016).

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